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A BALANCE FOR THE SOLUTION OF ALGEBRAIC EQUATIONS.

By R. P. BAKER, Chicago.

The ordinary balance with a riding weight and divided beam solves the equation $ax+b=0$. Here a represents the weight of the rider, x its distance from the zero of the scale positive or negative, and b the weight in one of the pans, positive or negative, according to the pair.

Consider the quadratic $F\equiv ax^2+bx+c=0$, with a, b, c, real, and a positive. Take three balance beams parallel and in same horizontal plane; their fulcrums in a line perpendicular to the beams. Let a rider of weight a be placed on the first beam, and a fixed weight b at unit distance right or left according to sign of b (or unit weight at distance b). If x is the distance of the rider from zero of the scale the moment turning the beam is $ax+b$. By some mechanism, approximately and conveniently by a long thread attached at distance unity on this beam and passing vertically both up and down (to transmit forces of either sign) over pulleys sufficiently distant to preserve approximate parallelism, a force proportional to $ax+b$ is transmitted to the second beam at a distance x from its fulcrum. The second beam also has a weight c at unit distance of appropriate sign (or unit weight at distance c). The moment on the second beam is now ax^2+bx+c. This may have either sign, but the sign of this does not tell us which way to vary x to reach a zero value, or whether one can be reached. The third beam has weight $2a$ at distance x, and b at unit distance, and has turning moment $2ax+b\equiv\partial F/\partial x$. If this is positive x must be made to move in the negative direction, or vice versa, to diminish the value of F. The third beam may be stopped and its bearing on the stops is the indicator as in the ordinary balance.

If the equation has imaginary roots the third or indicator beam reverses its moment without the second beam coming to an equilibrium. The three riders on the three beams can be moved so as to remain in a straight line perpendicular to the beams by an appropriate frame and vertical forks containing the axes of small rollers carrying the riders. The machine may be extended in principle to an equation of degree n, using $2n-1$ beams, and two indicators for the signs of x and $F'(x)$.

The machine may be made automatic by electrical attachments. In the case of the quadratic, when the sign of $F'(x)$ is positive, and $F(x)$ is positive, a connection through the stops may be used to start a rotation which moves the x-frame in the negative direction. For each change of sign the connection would reverse the current so that the sign of $-F(x)F'(x)$ gives the direction of movement of the x-frame. In case of imaginary roots the machine after some oscillation would come to rest in the minimum position.